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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/981,390	10/18/2001	Yuichi Naitou	NEC-472-US	7712

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EXAMINER
JOHNSTON, PHILLIP A

ART UNIT	PAPER NUMBER
2881	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/981,390	NAITOU ET AL.	
	Examiner	Art Unit	
	Phillip A Johnston	2881	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

P riod for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *05 December 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *5-7,10,11,13-35,43-51 and 55-78* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *5-7,10,11,13-35,43-51 and 55-78* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *18 October 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

13)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

a) ☐ The translation of the foreign language provisional application has been received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

Detailed Action

1. This Office Action is submitted in response to RCE / Amendment dated 12-05-2003, wherein Claims 1-4,8,9,12,36-42, and 52-54 are cancelled. Claims 5,14,43,44, and 55 are amended.

Claims Rejection – 35 U.S.C. 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 5-7,10,11,13-35,43-51, and 55-78 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,990,477, to Tomita, in view of Tomita, U.S. Patent No. 6,257,053, in further view of Adderton, U.S. Patent No. 6,172,506, and in still further view of Williams, U.S. Patent No. 6,210,982.

Tomita (477) discloses in FIG. 4 a scanning probe microscope that includes a quartz oscillator 4 and a piezoelectric oscillator 2 that are bonded to a quartz oscillator holder 25 with adhesive. A PZT device in the form of a flat plate is used as the piezoelectric oscillator. A quartz oscillator used for a clock or watch is used as the aforementioned quartz oscillator. When an AC voltage is applied to the PZT device, it

vibrates, forcing the quartz oscillator to vibrate. If the vibration frequency is made coincident with the resonant frequency (e.g., 32.7 kHz) of the quartz oscillator, the quartz oscillator resonates. Then, piezoelectric effect induces an electric charge on the electrodes of the quartz oscillator. The resulting current, is detected by a current/voltage amplifier circuit. Since a current proportional to the amplitude of the vibration of the quartz oscillator is produced, the state of the vibration of the quartz oscillator can be measured from the detected current. A cylindrical PZT scanner, a laminated PZT plate, or other structure may be conceivable as the piezoelectric oscillator, as well as the PZT plate. All of them are embraced by the present invention. Furthermore, quartz oscillators used in applications other than clocks and watches may be used as the quartz oscillator.

A probe 1 is held to the quartz oscillator by spring pressure of a resilient body 16. The used probe is prepared by chemically etching the tip of tungsten and machining it into a tapering form. The probe can be made of metals in this way. It may be conceivable that a cantilever of silicon or silicon nitride, an optical fiber, or a glass pipette is machined into a tapering form to fabricate the probe. This is embraced by the present invention. The tapering method may include mechanical polishing and heating-and-elongating processing, as well as the chemical etching. It may be considered that a magnetic film is deposited on the probe tip to make a magnetic force-sensing probe. In addition, it may be thought that a film of gold or platinum is formed to make a conductive probe. See Column 4, line 49-67; and Column 5, line 1-21.

It is implied herein that inducing resonant vibrations in the quartz oscillator, and thereby vibrating the conductive probe in accordance with Tomita (477) above, is equivalent to "inducing a resonant state on the conductive probe" as stated on page 6, line 31 of the Applicants specification.

Tomita (477) as applied above does not disclose the use of a probe that is electrically isolated from a piezoelectric vibrating unit, as recited in Claims 5,14,43,44, and 55. However, Tomita (053) discloses scanning probe microscope of the present invention is structured by a probe 1 formed in a probe needle form at its tip, an oscillation section formed by an oscillating piezoelectric member 2 and an alternating current generating means, a vibration detecting section formed by a detecting piezoelectric member 3 and a current/voltage amplifying circuit, a probe holder 4 for holding the probe and oscillating piezoelectric member and detecting piezoelectric member, a coarse movement mechanism 8 for approaching the probe to a sample, a sample-probe distance control means formed by a Z-axis finely moving element 7a and a Z servo circuit, a two dimensional scanning means formed by an XY finely moving element 7b and an XY scanning circuit, and a data processing unit for making a measurement signal into a three dimensional image.

The detecting piezoelectric member 3 is attached together with the oscillating piezoelectric member 2 to the probe holder 4. On the other hand, the probe 1 is fixed independently of the detecting piezoelectric member in the probe holder 4 with a tip and its vicinity pressed against the detecting piezoelectric member 3. At this time, pressure (pressing force) is exerted to a contact portion 3a with the detecting

piezoelectric member by deflecting the probe as it is, joining is stably made on the detecting piezoelectric member.

Tomita (053) also discloses that a beam was used as a detecting piezoelectric member 3, which is of quartz as a material of 0.25 mm width.times.0.1 mm thickness with 5 mm length. The oscillating piezoelectric member 2 used is a PZT formed in a plate shape with 10 mm length x 5 mm width x 0.5 mm thickness. The oscillating piezoelectric member 2 was adhesive-fixed in the holder main body 4. Further, the detecting piezoelectric member 3 is adhesive-fixed to the oscillating piezoelectric member 2. Incidentally, the oscillating piezoelectric member 2 and the detecting piezoelectric member 3 are electrically insulated.

It is inherent in Tomita (053) that since the probe is attached to the detecting piezoelectric member 3, then the probe is also electrically insolated from the vibrating piezoelectric member 2, and is therefore equivalent to a vibrating piezoelectric element electrically isolated from the probe, as recited in Claims 5,14,43,44, and 55.

Therefore it would have been obvious to one of ordinary skill in the art that the scanning probe apparatus and method of Tomita (477) can be modified to use the electrically insulated probe in accordance with Tomita (053), to improve reproducibility of measurement data .

Regarding Claims 20-23, Tomita (477) in view of Tomita (053) discloses nearly all the limitations of Claims 20-23, but does not include the use of “a diode detector for detecting the probe signal”, or “a characteristic signal that shows a capacitance between the probe and the sample”. Adderton (506); however discloses scanning

capacitance microscope wherein a surface of the sample is scanned in intermittent contact mode with an the AFM. The probe tip is electrically conductive and is electrically connected to a capacitance sensing circuit. The oscillation of the AFM probe modulates capacitance between probe tip and sample surface. The modulated capacitance is demodulated to yield the capacitance properties of the sample. See the Abstract.

Also, the amplitude of the signal is detected and outputted from the capacitance sensing circuit as a signal corresponding to the tip-sample capacitance, plus any parasitic capacitance. Other types of capacitive sensors, e.g. capacitive bridge circuits and impedance transformers, may also be used. See Column 1, line 65-67, and Column 2, line 1-4.

It is implied herein that the use of capacitive sensors in accordance with Adderton (506) is equivalent to the use of a "diode detector for detecting an output signal" as recited in Claims 20-23.

Therefore, it would have been obvious to one of ordinary skill in the art that one could design a scanning probe according to Tomita (477) in view of Tomita (053) and use capacitive sensors to detect the capacitance between the probe and the sample in accordance with the teaching of Adderton (506).

Regarding Claims 24-30, 45-47, and 55-78 ,Tomita (477) in view of Tomita (053) discloses a scanning probe microscope apparatus and method that includes nearly all the limitations of Claims 24-30, 45-47, and 55-78 but does not include the use of "a characteristic signal that shows a differential component of capacitance and current",

or " a calculating unit for calculating a differential component". Adderton (506); however, discloses that the amplitude of the capacitance modulation signal results from the electrical series combination of the modulated air gap capacitance, i.e. the capacitance between the tip and sample, and the substantially unmodulated capacitance of the sample surface, i.e. the sample capacitance. The signal amplitudes are demodulated, preferably at the frequency of the probe tip oscillation, or tapping, producing signals corresponding to the oscillation amplitude of the tip-sample capacitance. Alternatively, modulation at harmonics of the oscillation, or mixing of multiple oscillation frequencies, may be used. The demodulated capacitance signals may be stored, and may also be displayed as an image representative of the tip-sample capacitance as it varies across the sample surfaces. Such images may, for example, represent variations in carrier or impurity concentrations across semiconductor samples, or variations in the capacitance across a dielectric layer on the surface of a semiconductor sample or a conductor sample. Variations in dielectric capacitance may correspond to intrinsic properties such as trapped charge or dielectric constant or variation in thickness. See Column 1, line 40-67, and Column 2, line 1-20.

Adderton (506) also teaches in FIG. 1 an AFM including probe tip oscillator 1 that oscillates cantilever 2 and conductive probe tip 3 (collectively "probe 15"). Probe 15 may be magnetic, and can be oscillated by a magnetic actuator. Probe 15 moves toward and away from the surface of sample 4 in oscillatory motion, preferably at or near a resonant frequency of probe 15. Conductive probe tip 3 is electrically

connected to UHF capacitance sensor 6 via path 11. From sensor 6, modulated capacitance signals, corresponding to variations in the tip-sample system capacitance, pass on path 13 to lock-in amplifier 7. Lock-in amplifier 7 demodulates the capacitance signals at the oscillation frequency, or at some combination of frequency oscillation harmonics, of probe 15, resulting in signals that correspond to the modulation amplitude of the tip-sample capacitance. These signals pass on path 14 to control and computer 8. Signals on path 14 pass into AFM computer control electronics 8 to be stored for each data point with respect to X and Y position on sample 4. Such data may also be passed to display device 12 for display as an image of sample capacitance(s) on or across sample 4. This display could also show, simultaneously or otherwise, a topographic image of sample 4 obtained from the motion of probe 15. See Column 2, line 53-67, and Column 3, line 1-16.

It is implied herein that the use of modulated capacitance signals detected by a lock-in amplifier and stored as data in accordance with Adderton (506), is equivalent to detecting and calculating the "first differential component of capacitance and current" as recited in Claims 24-30.

It is also implied herein that the use of modulated capacitance signals, then detecting the demodulated signal at the oscillation frequency with a lock-in amplifier in accordance with Adderton (506), is equivalent to detecting and calculating the "second differential component of capacitance and current" as recited in Claims 24-30.

Therefore, it would have been obvious to one of ordinary skill in the art that the Tomita (477) in view of Tomita (053) scanning probe apparatus and method could be

modified with the modulated and demodulated capacitance signals representative of the tip-sample capacitance as it varies across the sample surfaces, in accordance with the teaching of Adderton (506), to extend the applicability of the Tomita (477) in view of Tomita (053) invention to detect variations in carrier or impurity concentrations across semiconductor samples, if so desired.

Regarding Claims 14-35, 43-51 and 55-78, Tomita (477) in view of Tomita (053), and in further view of Adderton (506), discloses a scanning probe microscope apparatus and method that includes nearly all the limitations of Claims 14-35, 43-51 and 55-78, but does not disclose "a voltage applying unit for applying an AC voltage to the sample". Williams (982); however, discloses a method that can also be applied to data obtained from the Scanning Probe Microscope when it is operating in a mode wherein the AC bias voltage applied to the substrate is held constant and the signal is the change in depletion capacitance. In step one of this alternative embodiment, the tip of the probe is scanned over the two-dimensional surface of the substrate material being probed. This scanning is executed in accordance with the constant AC bias voltage mode, in contrast to the constant capacitance mode. The second step is to take measurements of the change in capacitance. This is done to obtain a corresponding probe capacitance signal. The change in capacitance measurements are recorded as a function of the position of the probe on the surface of the substrate.

These first two steps are executed to thereby experimentally acquire change-in-capacitance data to be input into a first order model, which assumes uniform dopant

density under the probe at each point on the substrate material. See Column 7, line 19-38.

Therefore it would have been obvious to one of ordinary skill in the art that the scanning probe microscope of Tomita (477) in view of Tomita (053), and in further view of Adderton (506), can be modified to apply an AC bias voltage to the sample in accordance with Williams (982) to improve the accuracy of dopant density profiling in semiconductor substrates.

Conclusion

4. Any inquiry concerning this communication or earlier communications should be directed to Phillip Johnston whose telephone number is (703) 305-7022. The examiner can normally be reached on Monday-Friday from 7:30 am to 4:00 pm. If attempts to reach the examiner by telephone are unsuccessful, the examiners supervisor John Lee can be reached at (703) 308-4116. The fax phone numbers are (703) 872-9318 for regular response activity, and (703) 872-9319 for after-final responses. In addition the customer service fax number is (703) 872- 9317.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703 308 0956.

PJ

December 30, 2003